In-Situ Decontamination of Aquifers by Surfactant Solubilization of DNAPL's

Developer: Intera, Inc.
Contract Number: DE-AC21-92MC29111
Crosscutting Area: ESP

Subsurface Contaminants FOCUS AREA

Problem:

Contamination of aquifers by dense, non-aqueous phase liquids (DNAPLs) is a major factor in the failure of pump-and-treat systems to decontaminate these aquifers in reasonable time periods. Some liquid hydrocarbons are more dense than water so they sink readily into the aquifer system when released. DNAPL also have a very low solubility in water so they tend to exist as pockets at the location to which they have migrated. They dissolve slowly, leading to very slow rates of removal by conventional pump-and-treat opertions. Because of their high carcinogenicity, the low levels found in the groundwater are still hazardous and exceed the maximum concentration limits set by EPA for groundwater.

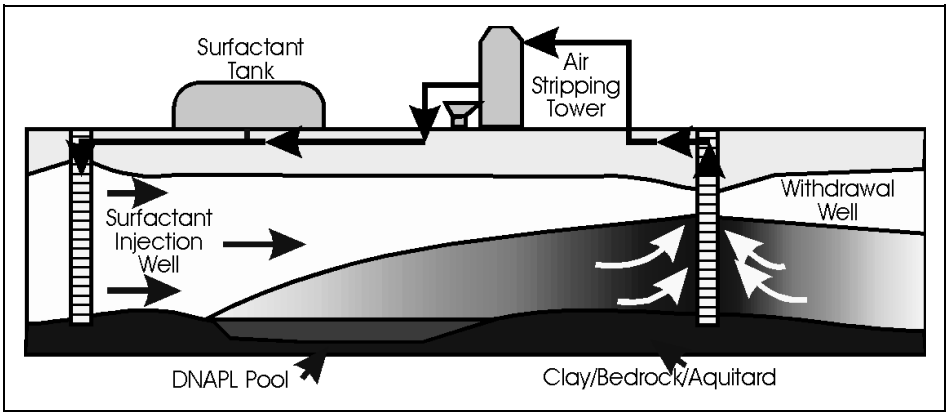
Solution:

A practical, cost-effective process to remove DNAPLs using in situ surfactant flushing as an advanced form of pump-and-treat, with chemically-enhanced solubilization (CES) of DNAPLs.

Benefits:

- Decreases significantly the number of pore volumes of groundwater that must be withdrawn from the aquifer

- Significant cost and time savings compared to current methods



Technology:

Chemically-enhanced solubilization through surfactant flushing is, in essence, an enhancement of traditional pump-and-treat technology for groundwater contaminated with DNAPLs. Adding surfactants to the contaminated subsurface can greatly increase DNAPL extraction efficiency by increasing the apparent water solubility of the hydrophobic organic chemicals. Surfactants, or surface-active agents, have polar and nonpolar groups that exhibit hydrophilic and hydrophobic properties, respectively.

The solubilization mechanism, which is at the heart of the CES process, is the formation in groundwater of micelles, (i.e., colloidal clusters of nonionic surfactants) in which the molecules of the DNAPL are dissolved and then transported by the groundwater. In the field, CES works siimilarly to pump-and-treat

operations except that dilute surfactant solutions are injected into the contaminated aquifer and withdrawn together with the solubilized DNAPLs for treatment.

At certain characteristic concentrations, surfactants exhibit marked changes in several physical and chemical properties, (e.g., electrical conductivity, interfacial tension, and detergency). The concentration of the surfactant at which these phenomena occur is known as the critical micelle concentration. At this concentration, the polar and nonpolar groups become oriented such that they form colloidal clusters of molecules in solution.

The clusters are characterized by the interfacing of the hydrophilic groups with the water molecules on the outside of the cluster, while the hydrophobic groups are arranged pointing towards the interior of the cluster. In the removal mechanism, the hydrophobic DNAPL molecules are solubilized inside the micellar assemblage of the surfactant and thus solubilized within the groundwater for pump-and-treat operations.

Contacts:

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advanced treatment processes for DNAPLs. For information on this project, the contractor contact is:

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